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# SPACING AND UNDERSTORY VEGETATION AFFECT GROWTH OF PONDEROSA PINE SAPLINGS

by

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What is the best spacing of ponderosa pine *(Pinus ponderosa)*[1/] for maximum production of usable wood? How does understory vegetation influence tree growth at different spacings? These questions are the subject of a spacing study installed in suppressed ponderosa pine saplings on the Pringle Falls Experimental Forest in central Oregon.

Principal objectives of the study are to determine (1) time required for trees at various densities to occupy a given amount of growing space and (2) size of trees produced at the end of this period. Even though the study has not yet fulfilled these objectives, early results merit the attention of ponderosa pine forest managers.

This research note presents a 4-year record of diameter and height increment of residual saplings following overstory removal and thinning.

## EXPERIMENTAL AREA

The study is at an elevation of about 4,400 feet on an east-facing slope. Precipitation averages 24 inches per year. Most rainfall occurs in late fall, winter, and spring. Summers are dry. Soil is a Regosol

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1/ Authorities for common and scientific names in this publication are: for trees, "Check List of Trees of the United States (Including Alaska)," by Elbert L. Little, Jr.; for shrubs, "Standardized Plant Names," by Harlan P. Kelsey and William A. Dayton.

developed in dacite pumice originating from the eruption of Mount Mazama (Crater Lake). The soil, averaging 33 inches in depth, is underlain by a sandy loam paleosol developed in volcanic ash containing cinders and basalt fragments.

The unthinned timber stand was typical old-growth ponderosa pine, with a dense 40- to 70-year-old understory of about 7,000 saplings per acre. Heights of overstory trees indicated that site quality throughout the study area uniformly averaged site IV.[2/] Understory vegetation was mostly antelope bitterbrush *(Purshia tridentata)*, snowbrush ceanothus *(Ceanothus velutinus)*, and pine manzanita *(Arctostaphylos parryana* var. *pinetorum)*, although sedges, grasses, and other herbs were present.

## STUDY ESTABLISHMENT AND DESIGN

Thirty 1/5-acre rectangular plots with at least 1,000 well-distributed saplings per acre were established (fig. 1). Overstory was carefully harvested, and plots were thinned to randomly assigned densities of 1,000, 500, 250, 125, and 62 trees per acre.[3/] Each

**Figure 1.--Typical ponderosa pine stand before harvest of mature overstory and application of spacing treatments to the dense, suppressed sapling understory.**

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[2/] Meyer, Walter H. Yield of even-aged stands of ponderosa pine. U.S. Dept. Agr. Tech. Bul. 630, 60 pp., illus. 1938.

[3/] Barrett, James W. Intensive control in logging ponderosa pine. Iowa State Jour. Sci. 34: 603-608, illus. 1960.

spacing treatment was replicated six times. Average diameters and heights of residual trees for the various stand densities in 1959 were as follows:

| | Diameter (Inches) | Height (Feet) |
|---|---|---|
| Trees per acre: | | |
| 1,000 | 1.9 | 11.6 |
| 500 | 1.7 | 12.2 |
| 250 | 2.0 | 10.9 |
| 125 | 2.3 | 13.2 |
| 62 | 2.2 | 11.7 |

No reserve trees were over 3.1 inches d.b.h.

Understory vegetation was removed from three plots of each spacing treatment, and these plots were kept as free as possible of subsequently developing vegetation. Understory vegetation left on the remaining plots of each spacing treatment was measured as percent cover by line point sampling using 100 points per plot.[4/]

Logging of overstory and thinning of saplings started in the fall of 1957 and was completed in the fall of 1958 (fig. 2). All thinning slash was removed from the study plots and burned.

Figure 2.--Sapling stand directly after thinning to 1,000 trees per acre. Thinning slash has been removed and understory vegetation left.

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[4/] Heady, Harold F., Gibbens, Robert P., and Powell, Robert W. A comparison of the charting, line intercept, and line point methods of sampling shrub types of vegetation. Jour. Range Mangt. 12: 180-188, illus. 1959.

The first diameter and height measurement of all residual saplings was in the fall of 1959 and the second (four growing seasons later) in the fall of 1963.

Diameters at breast height were measured with steel tape to the nearest 0.1 inch. Heights were measured with a sectioned aluminum pole to the nearest 0.1 foot.

## RESULTS

Sapling response to spacing treatments was shown quantitatively by height and diameter measurements and morphologically by crown vigor. After release, saplings produced long, large needles resulting in a distinct improvement in crown vigor, most apparent at the lower densities (fig. 3). Some individual saplings, thinned to a wide spacing and having better than average crowns before release, showed remarkable response in diameter growth after thinning (fig. 4).

**Figure 3.--Trees at a density of 62 per acre show vigorous crown development 4 years after treatment. Compare tree vigor with that of trees in figure 2.**

Figure 4.--Section from a 4-inch ponderosa pine sapling, released from competition about 6 years, shows the capacity of a suppressed tree to respond to release.

## Diameter Increment

Stand density had a highly significant effect on diameter increment (fig. 5). Where understory vegetation (brush and herbs) was left undisturbed, trees grew at the rate of 3.0 inches d.b.h. per decade where 62 trees per acre were left. Where 1,000 trees per acre remained with understory vegetation, diameter increment was only 1.5 inches per decade.

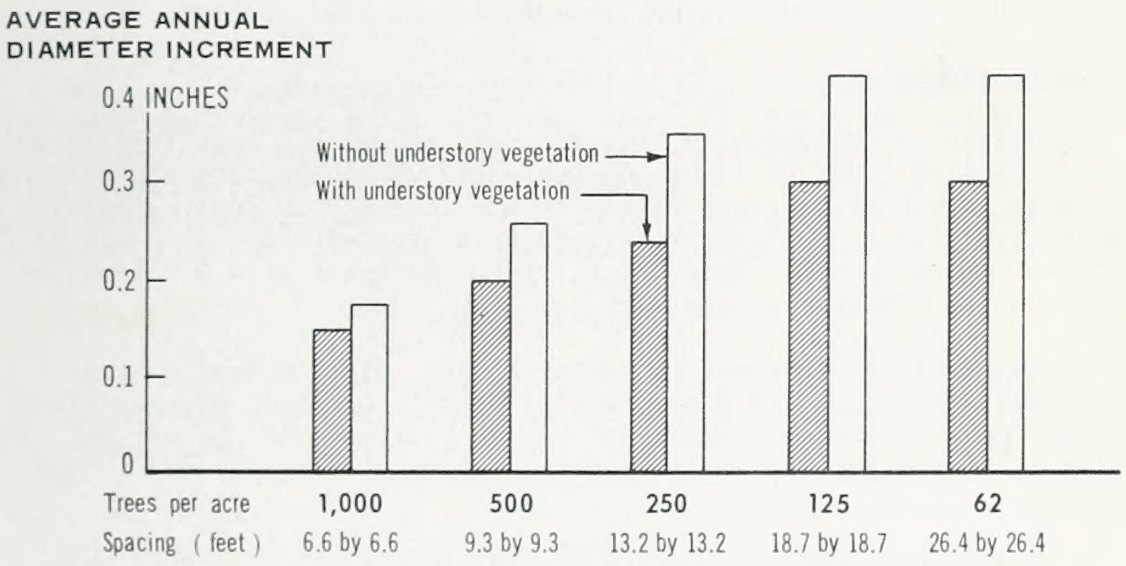


Figure 5. -- Average annual diameter increment of ponderosa pine saplings following thinning.

The effect of competition was also evident within the range of spacing treatments. For example, trees at a density of 250 per acre made significantly less diameter growth than those at 125 per acre and were, therefore, showing the effects of competition after only a few years. Saplings growing at densities of 125 per acre and less were probably not in competition with each other during the 4-year measurement period.

The removal of understory vegetation significantly increased diameter increment throughout the range of tree spacings. In addition, there was a highly significant trend for understory vegetation to have a more pronounced effect on diameter increment at the wider spacings.

Average percent cover of understory vegetation also increased with wider tree spacing. Although this trend was nonsignificant (5-percent level), it suggested that when tree spacing is increased to stimulate diameter growth, development of understory vegetation may also be stimulated. Where undisturbed, understory vegetation cover increased from 29 percent in 1959 to 38 percent in 1963. Vegetation was about three-fourths brush and one-fourth grasses and other herbs.

A further analysis of diameter increment was made, considering only the 62 largest (in 1959) equally distributed trees per acre from each of the stand density treatments. These 62 largest trees per acre will probably constitute a major portion of the stems that will make up the final harvest. They showed a highly significant increase in diameter increment with decreasing stand densities. Therefore, growth of even the largest trees--those usually occupying the most favorable position in the stand--was not independent of tree spacing.

Height Increment

Height growth was also significantly (1-percent level) affected by stand density. Height increment increased with wider spacing (fig. 6). Average growth of saplings ranged from a low of 0.20 foot per year where 1,000 trees per acre were left to a high of 0.5 foot where 62 trees remained. Some vigorous, full-crowned trees grew 0.9 foot per year at the widest spacing.

An analysis of height increment of the largest trees in each density, similar to the analysis of diameter increment of the largest trees reported above, showed that height increment of the largest trees also increased significantly (5-percent level) with decreased stand density.

Understory vegetation had a highly significant effect on height growth. On plots where understory vegetation was removed, height increment was increased by about one-third at densities of 500, 250, 125, and 62 trees per acre.

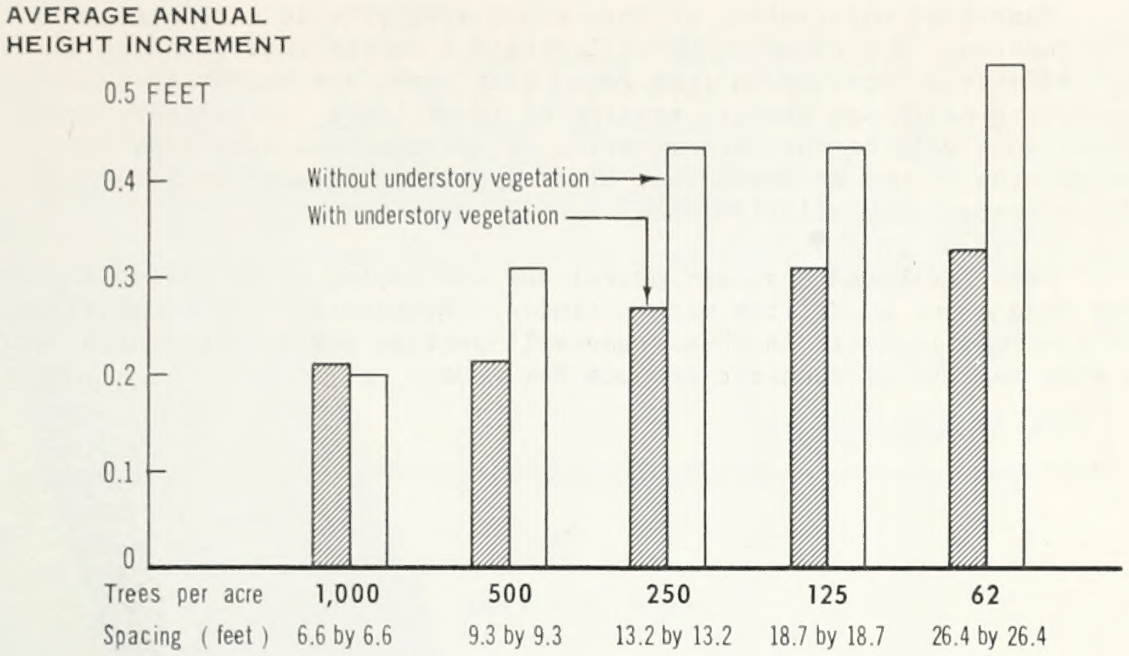


**Figure 6. -- Average annual height increment of ponderosa pine saplings following thinning.**

## Mortality

No tree mortality occurred in this study. Extensive precautions were taken to protect the stand from damage by porcupines and snowbend, the two greatest threats to maintaining the designated tree densities. Mortality will probably occur in the future as tree crowns expand and lower crown class trees succumb to competition. Continued observation of these plots will disclose the effect of spacing on mortality.

## CONCLUSIONS AND DISCUSSION

Tree spacing and presence of understory vegetation are major factors influencing diameter and height growth of suppressed ponderosa pine saplings after overstory harvest. Although this conclusion is based on only a 4-year measurement period following thinning treatment, data appear reliable enough to make short-term growth predictions. Subsequent observations will improve accuracy of such predictions for application to the sizable acreage of similar stands. Repetition of study techniques used here will probably be necessary to determine applicable growth predictions for other sites and soil types.

Continued observation of this study will provide a wide range of information. For example, we will obtain a better understanding of the effects of spacing on tree form, limb size, and branching habits, including death and natural pruning of lower limbs. Of perhaps equal importance will be the determination of optimum tree densities for production of not only wood but also vegetation, useful as forage for livestock and wildlife and for soil building.

Data presented here are useful for confirming or modifying existing management guidelines within limits. Eventually, the broad range of spacings included in this study will provide yield information for a wide variety of economic demands for wood.